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(NASA-Case-NPO-12.131-3) GAS. PATH SEAL N80-18400
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LEW

INVENTION ABSTRACT

GAS PATH SEAL

A gas path seal for a turbine engine or compressor is provided.

The gas path seal comprises a shroud of material wearable or abradable relative to the material of the turbine or compressor blades and closely spaced from the blade tips. A compliant backing, preferably of several layers of corrugated metal or a compliant material covered with a thin layer of ductile material, is provided about the shroud, and a rigid mounting surrounds the compliant backing.

If a transient causes a blade tip to strike the shroud, the compliance of the backing tends to permit the shroud to yield somewhat and in the corrugated metal shroud a restorative force is applied so that the resultant worn or abraded portion tends to return to its original dimension. In the compliant shroud with the thin ductile layer the material yields with little wear to the shroud or the blades. Hence in either case the useful life of the shroud is increased.

This novel feature is a compliant backing between the shroud and mounting. As a result normal forces during a blade rub are limited and wear is reduced and the life of the shroud is lengthened for a design of comparable clearance of blade to shroud.

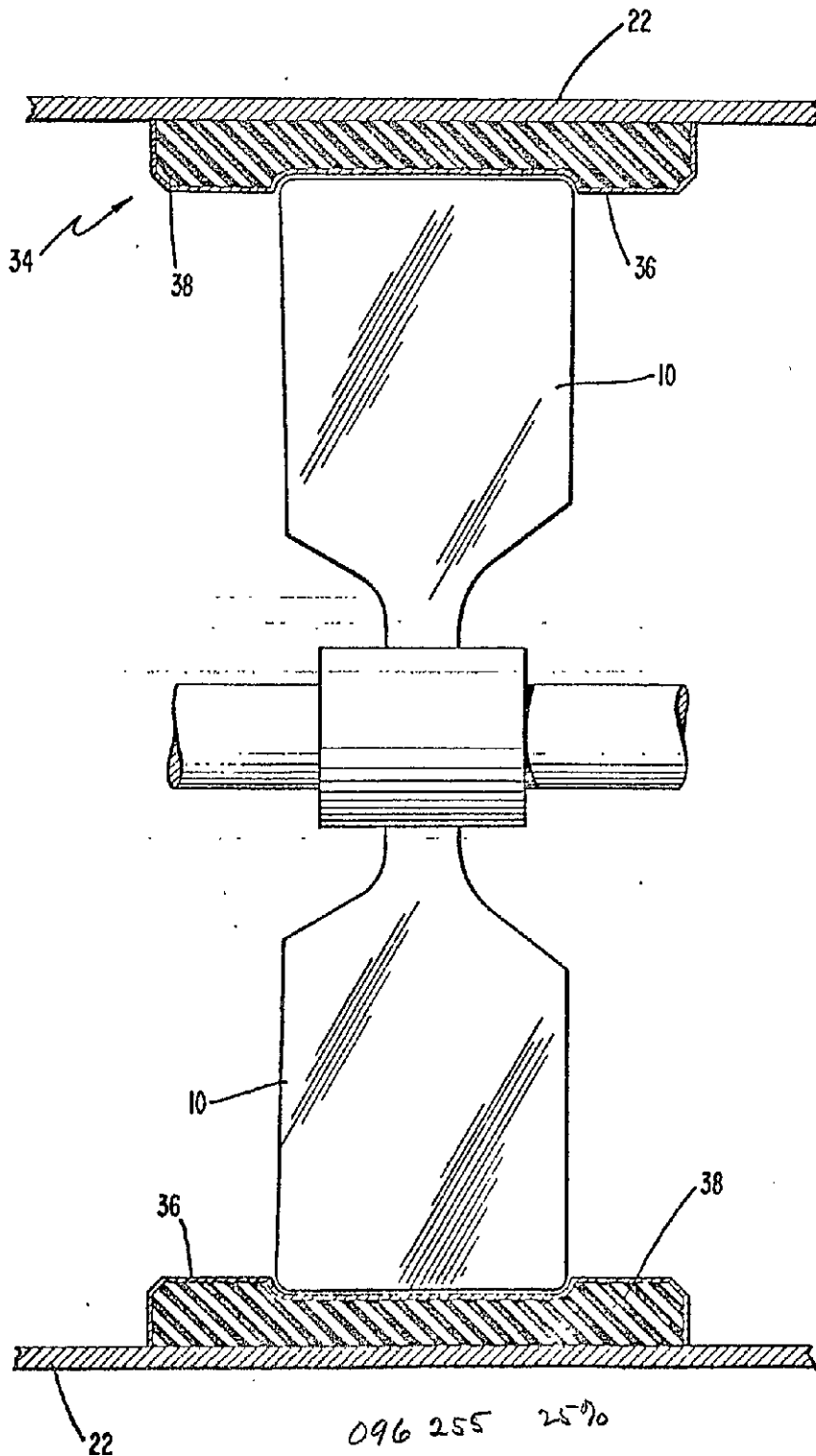
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EVALUATOR: Robert D. Johnson

SERIAL NO. : 96,255

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EMPLOYER: NASA/Lewis Research Center



APPLICATION FOR LETTERS PATENT

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT ROBERT C. BILL AND LAWRENCE P. LUDWIG

citizens of the United States of America, and employees of the
U. S. Government

and residents of Rocky River, Ohio and Fairview Park, Ohio, respectively

have invented certain new and useful improvements in _____
COMPOSITE SEAL FOR TURBOMACHINERY

of which the following is a specification

ABSTRACT OF THE DISCLOSURE

A gas path seal suitable for use with a turbine engine or compressor is provided. A shroud wearable or abradable by the abrasion of the rotor blades of the turbine or compressor shrouds the rotor blades.

5 A compliant backing surrounds the shroud. The backing is a yieldingly deformable porous material covered with a thin ductile layer. A mounting fixture surrounds the backing.

ORIGIN OF THE INVENTION

10 The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

RELATED APPLICATION

15 This application is a division of copending application serial No. 931,090 filed August 8, 1978, and which, in turn, is a division of application serial No. 801,290 filed May 27, 1977 and now U.S. patent No. 4,135,851.

BACKGROUND OF THE INVENTION

20 In the design of turbines or compressors or the like, especially those of high speed, it is understood that close tolerance between the tips of the blades and the surrounding shroud or housing which seals one side of the blades from the other is desirable. Such a seal reduces the return flow of fluid from the high pressure to the low pressure side. The closer the shroud surrounds the tips of the blades, the more efficient
25 is the turbine or compressor. Aerodynamic losses are also reduced by closer fitting of the blade tips to the shroud.

Nevertheless the clearance dimensions are dynamic. They increase and decrease with temperature and with mechanical and aerodynamic forces and may increase or decrease faster than the rotor. The clearance may
30 also decrease, for example in one direction, under so-called shock loading

when an airplane makes a sudden maneuver that subjects the parts to unusual acceleration forces, causing a differential expansion or movement of the parts.

The prior attack on such problems has been to design the shroud to fit closely, say within 20 to 30 mils. (i.e. about 5 to 7 mm.) about the tips of the blades at ambient temperature. Moreover, the shroud about the blade has been designed to be wearable or abradable relative to the blade tips. Then if there is a thermal transient or shock loading that causes a blade tip to strike the shroud, the blade material flakes off or abrades the shroud material, which may be a sprayed coating or sintered material of low density. Thus, the shroud material is abradable (or wearable) with respect to the blade material. However, such wear is not readily achieved in practice. By the arrangement of the present invention the blade tip may be designed to rotate in close proximity to the shroud without fear of cataclysmic destruction of either blade or shroud, should contact between the two occur due to thermal transient or shock loading.

SUMMARY OF THE INVENTION

According to the present invention, there is provided in combination for a turbine rotor or the like a stator shroud of material wearable relative to the blades, a compliant backing of a yieldingly deformable porous material with a thin ductile layer, and a rigid mounting surrounding the compliant backing. The compliance of the backing tends to cause the shroud when tipped or touched by the rotating blade because of some transient condition to yield somewhat. Then, even though abraded or worn, the compliance of the backing provides a restorative force tending to return the shroud at its worn portion toward its original dimension. In the preferred embodiment wherein the compliant backing has a ductile top coating, the normal forces are limited and the blade wear is reduced. Hence any gap is less than in prior instance of such wear, and the useful life of the shroud is increased.

BRIEF DESCRIPTION OF THE DRAWING

The objects, advantages and novel features of the invention will be more fully apparent from the following detailed description when read in connection with the accompanying drawing which is a schematic view, in longitudinal cross section, of a preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the figure, a rotor blade 10 of a turbine compressor, for example, rotates about an axis 12 tending to force the fluid in which it operates along this axis. A shroud surrounds the blade 10 and is substantially concentric with the axis 12. The shroud may be of suitable material abradable relative to the material of the blade 10.

A compliant backing surrounds the shroud. The abradable shroud is bonded to the concave, inner face of the backing. The backing is inserted and bound to a housing 22.

Previous abradable seals, even though various materials for the shroud have been proposed, such as sintered metals, metal honeycombs, and porous ceramics, have not provided a desirable flexibility. After abrasion due to a transient condition such as a thermal transient or shock loading, the gap or wear produced by the rub or contact is generally larger than the interference depth because of tearing out, galling, and spalling.

The drawing illustrates the preferred embodiment in which the blade 10 is shown at an instant when forces have caused the tip of the blade to contact the shroud. The compliant backing in this case is slightly compressed, the compression as illustrated in the drawing in exaggerated fashion.

The material of the shroud 34 may be a relatively thin layer 36 of deformable metallic material. The backing 38 is a compliant material, such as low density sintered metal, or gas blown plastic. The metal or metal alloy layer 36 may be a dense plasma sprayed soft metal, such as aluminum, or a bonded metal sheet or foil.

When the blades, as a result of forces such as described hereinbefore, rub against the shroud, the thin metallic layer 36 is deformed into the compliant substrate material 38. In effect because of the compliant substrate material 38 the magnitude of a force normal to the surface of the shroud is limited. This normal force is measured in the radially inward direction. A larger displacement simply causes a greater deformation without greatly increasing the normal force. Therefore, in effect, the compliant substrate material limits the magnitude of the normal force which can be developed between the blade tip and the shroud. The more porous and yieldingly deformable the substrate 38 and the thinner the shroud layer 36, the smaller will be the normal force. Because the normal force is low when the blades rub against the shroud, blade wear is reduced.

Currently used shroud materials such as sintered metal or felt metals have disadvantages of low erosion resistance, aerodynamic roughness and porosity which permit back leakage. An arrangement as described in connection with the drawing with the shroud layer as suggested herein provides an aerodynamically smooth surface and high erosion resistance and is substantially less permeable from a leakage standpoint. Furthermore, any wear debris produced in the rub is less than that produced in other shroud arrangements. Wear debris tends to plug up turbine cooling holes and to plate out or stick on compressor blades causing aerodynamic losses.

Various modifications may be made. For example, metallic sheets (not illustrated) may be distorted by wires aligned parallel to axis 12 to form corrugations for the compliant backing, or these corrugations might extend at angles of less than 90° to the axial direction. The compliant backing 38 may use fibermetal, and instead of the thin metallic layer, material such as high temperature resistant ceramic may be used.

- 5 -